# Diamond and Hill Lakes Aquatic Plant Management Plan Revision 2007
# Excerpt from Yellow Creek Lakes Diagnostic Study

**Kosciusko County, Indiana**

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Prepared for:
**Diamond Lake Conservation Club**
**2227 Coral Bay Court**
**Fort Wayne, Indiana 46814**


Prepared by:
JFNew
c/o Sara Peel
708 Roosevelt Road
Walkerton, IN 46574
Phone: 574.586.3400 Fax: 574.586.3446

## Introduction

Diamond and Hill lakes' aquatic plant communities were assessed as part of the diagnostic study on August 27, 2007. Survey results indicate that Diamond Lake contains a relatively diverse, yet sparse aquatic plant community, while Hill Lake contains a relatively dense, yet non-diverse aquatic plant community. Generally, poor water clarity limits the aquatic plant community present in Diamond Lake. As such, many aquatic plants that form dense communities early in the growing season are limited later in the summer by this poor water clarity. In Hill Lake, chara dominates the shallow, sand bottom portions of the lake with dense Eurasian watermilfoil ringing much of Hill Lake's shoreline. Both lakes are negatively impacted by exotic species. Therefore, shoreline treatment of exotic species and education of lakeshore property owners and lake users on the impacts of exotic, invasive aquatic species should be considered in the future The following sections detail specifics of the aquatic plant survey, provide recommendations for future actions, and identify costs associated with these efforts.

## Macrophyte Assessment Methods

JFNew surveyed Diamond and Hill lakes' plant communities on August 27, 2007 according to the Indiana Department of Natural Resources (IDNR) sampling protocols (IDNR, 2007). The survey included two components: 1) a general survey to identify aquatic plants present in the lakes and to map exotic species locations within the lakes and 2) a Tier II survey, which requires sampling at specific points throughout the lakes' littoral zones.

In order to create exotic species maps, JFNew examined the entire littoral zone of the lakes. A survey crew, consisting of one aquatic ecologist, one technician, and a citizen volunteer boat driver, surveyed both lakes in a clockwise manner. The survey crew drove their boat in a zig-zag pattern across the littoral zone of the lake while visually identifying plant species. The crew maintained a tight pattern to ensure the entire zone was observed. Additionally, in areas of dense plant coverage, rake grabs were performed to ensure all species were identified. All identified species were recorded; all exotic species locations were mapped on an aerial photograph.

The Tier II survey protocol is designed to develop a quantitative estimate of the density and diversity of all submerged aquatic species within each lake. The survey protocol requires that a specific number of sampling locations occur within each lake. Additionally, the sampling points are stratified over the entire depth of the lake's littoral zone as defined by the Tier II protocol (IDNR, 2007). Total points sampled per stratum were determined as follows:

1. Appendix D of the survey protocol was consulted to determine the number of points to be sampled and the maximum sampling depth. This determination was based on the lake size (surface area) and trophic status.
2. Table 3 of the survey protocol was referenced as an indicator of the number of sample points per stratum. Table A in this report lists the sampling strategy for Diamond and Hill lakes while Figures A and B display the points sampled during each lake's survey.

Stratum refers to the depth at which plants were observed. Dominance presented in subsequent tables was calculated by the IDNR protocol. The frequency per species presented in subsequent tables provides a measure of the frequency of a species sampled in each stratum.

**Table A. Tier II sampling strategy for Diamond and Hill lakes using the 2007 Tier II protocol.**

| Lake | Size | Trophic Status | Number of Points | Stratification of Points |
|---|---|---|---|---|
| Diamond Lake | 79 acres | Eutrophic | 40 | 17 pts 0-5 foot stratum<br>13 pts 5-10 foot stratum<br>10 pts 10-15 foot stratum |
| Hill Lake | 67 acres | Mesotrophic | 40 | 10 pts 0-5 foot stratum<br>10 pts 5-10 foot stratum<br>10 pts 10-15 foot stratum<br>10 pts 15-20 foot stratum |

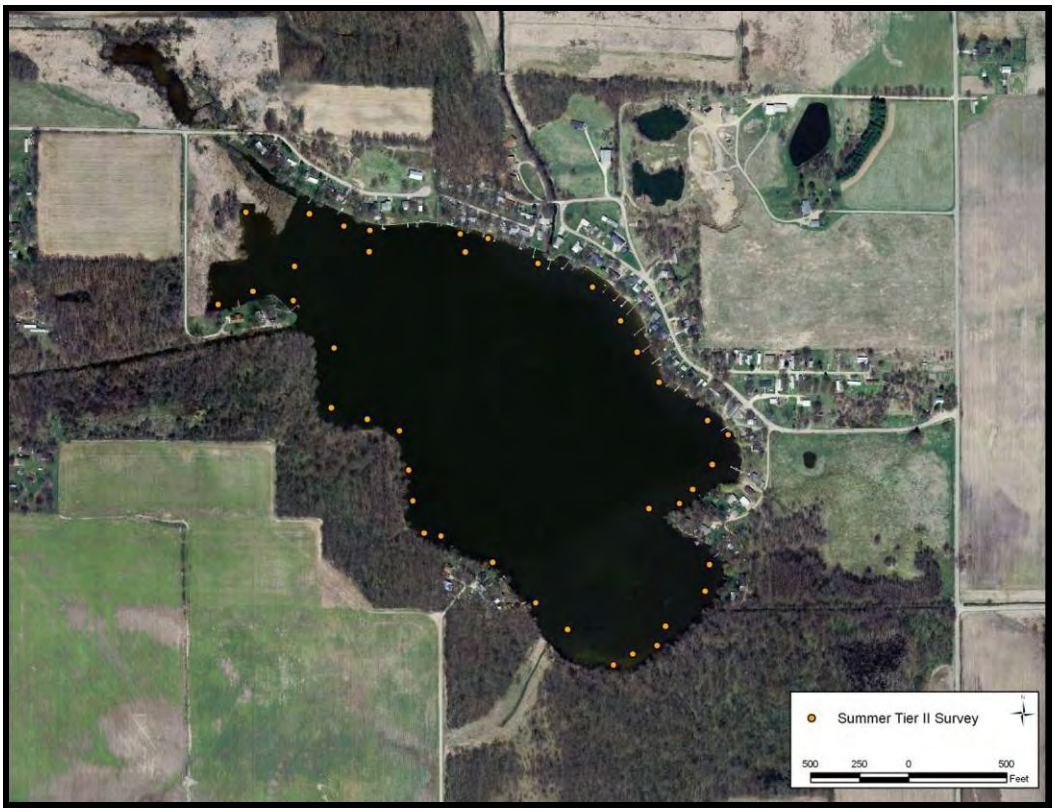



**Figure A. Points sampled during the Tier II aquatic plant assessment of Diamond Lake.**

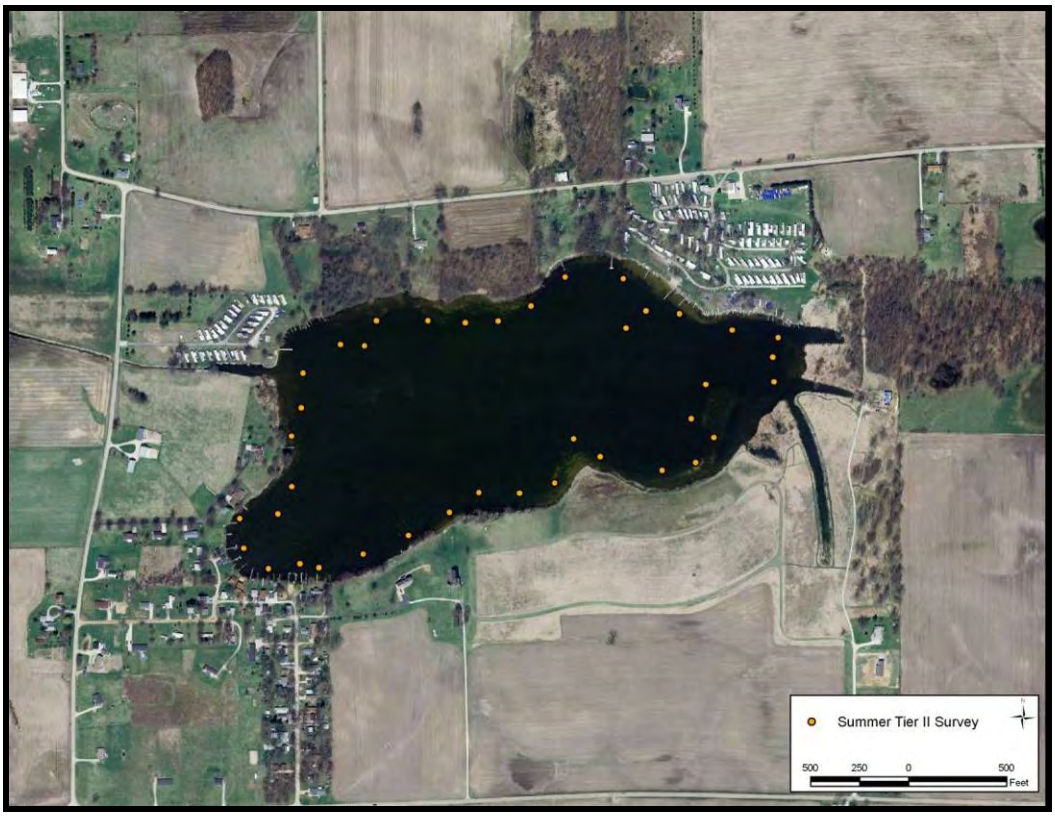



**Figure B. Points sampled during the Tier II aquatic plant assessment of Hill Lake.**

The data from the surveys are used to calculate different lake characteristics and community and species metrics. The different characteristics and metrics calculated from the Tier II method are defined below:

- Littoral depth: Maximum depth that aquatic vegetation is present.
- Total sites: Total number of sites sampled.
- Littoral sites: Number of sites within the littoral depth.
- Secchi depth: Measurement of the transparency of water.
- Species richness: count of all submersed plant species collected.
- Native species richness: count of all native submersed plant species collected.
- Maximum number of species per site: highest number of species collected at any site.
- Mean number of species per site: The average number of all species collected per site.
- Mean number of native species per site: The average number of native species per site.
- Species diversity index: Modified Simpson's diversity index—a measure that provides a means of comparing plant community structure and stability over time.
- Frequency of occurrence: Measurement of the percentage of sampled sites where each species is present.
- Relative frequency of occurrence: Measures the distribution of plants occurrence throughout the lake in relation to each other.
- Dominance index: Combines the frequency of occurrence and relative density into a dominance value. This value characterizes how dominant a species is within the aquatic plant community (IDNR, 2007).

## Macrophyte Inventory and Tier II Results
## Diamond Lake

*Inventory*

Transparency was found to be 3.5 feet in Diamond Lake during the Tier II survey. Diamond Lake supports a varied aquatic plant community. The community extends from the lake's shoreline to water that is just over 9 feet (2.7 m) deep. In total, 25 aquatic plant species inhabit the water and shoreline of Diamond Lake (Table B). The LARE protocol used to conduct the aquatic plant survey requires surveyors to note all plant species observed from a boat. Thus, plants in the wetland complexes adjacent to the lake were only counted if they were visible from the boat. If these wetland complexes had been explored in greater detail, it is likely that the total number of plant species would increase significantly.

Of the 25 species observed in Diamond Lake, eleven species were submerged plant species. Of the eleven submerged species, nearly all of those are adapted to high nutrient environments. Only three of the submerged species were pondweeds (i.e. belonging to the *Potamogeton* genus), which are typically adapted to better water quality conditions. However, most of these species were identified in relatively low density. Compared to other lakes in the region, this diversity of submerged species represents relatively normal species richness for the submerged strata. Southern naiad, Eurasian watermilfoil, musk grass, and Sago pondweed dominated the submerged plant community and were observed throughout the lake. Two exotic species, Eurasian watermilfoil and reed canary grass, were identified within or adjacent to Diamond Lake.

**Table B. Plant species observed in Diamond Lake as identified on August 27, 2007.**

| Scientific Name | Common Name | Stratum |
|---|---|---|
| *Ceratophyllum demersum* | Coontail | Submergent |
| *Chara* species | Musk grass species | Submergent |
| *Decodon verticillatus* | Whirled loosestrife | Emergent |
| *Elodea canadensis* | Common waterweed | Submergent |
| *Equisetum arvense* | Field horsetail | Emergent |
| *Filamentous algae* | Filamentous algae | Algae |
| *Hibiscus* species | Hibiscus species | Emergent |
| *Lemna minor* | Common duckweed | Floating |
| *Myriophyllum exalbescens* | Northern watermilfoil | Submergent |
| *Myriophyllum spicatum* | Eurasian watermilfoil | Submergent |
| *Najas flexilis* | Slender naiad | Submergent |
| *Najas guadalupensis* | Southern naiad | Submergent |
| *Nuphar advena* | Spatterdock | Floating |
| *Phalaris arundinacaea* | Reed canary grass | Emergent |
| *Polygonum hydropiperoides* | Swamp smartweed | Emergent |
| *Pontederia cordata* | Pickerel weed | Emergent |
| *Potamogeton amplifolius* | Large-leaf pondweed | Submergent |
| *Potamogeton gramineus* | Grassy pondweed | Submergent |
| *Potamogeton illinoensis* | Illinois pondweed | Submergent |

| | | |
|---|---|---|
| *Sagittaria latifolia* | Common arrowhead | Emergent |
| *Scirpus acutus* | Hard-stem bulrush | Emergent |
| *Scirpus pungens* | Chairmaker's rush | Emergent |
| *Stuckenia pectinatus* | Sago pondweed | Submergent |
| *Typha* x *glauca* | Blue cattail | Emergent |
| *Typha latifolia* | Broad-leaf cattail | Emergent |

The species richness of the emergent strata was the same as the submerged strata, while the floating strata's richness was much lower than the emergent and submerged strata. Eleven (11) emergent species were noted bordering Diamond Lake's edges, while only two floating species were observed in the lake. (It is important to note that there are significantly fewer floating aquatic species that are native to Indiana lakes compared to the number of emergent and submerged species. Consequently, many lakes possess low numbers of floating species.) The most common emergent species include reed canary grass, whirled loosestrife, and cattails. The most common floating species are spatterdock, white water lily, and duckweed.

*Tier II*

During the Tier II survey, southern naiad dominated the plant community over all sampled depths (0-15 feet; Table C). (Appendix A details raw data collected during the Tier II aquatic plant survey.) Southern naiad was found at the highest percentage of sites throughout the entire sampled water column (35%) and also had the highest relative density (0.45). Throughout the entire sampled water column, Eurasian watermilfoil, musk grass, and Sago pondweed were each present at 10% of the sites; slender naiad and coontail were each present at 7.5% of the sites; grassy pondweed, large-leaf pondweed, northern watermilfoil, and common waterweed were each present at 5% of the sites; and Illinois pondweed was present at only 2.5% of the sites. With regards to dominance, southern naiad dominated the submerged plant community throughout the entire sampled water column with a dominance of 9.0. (A dominance of 200 represents a perfect score or the highest dominance possible within Diamond Lake. This results from multiplying the highest density score (5) by the number of sites where plants were sampled (40). Dominance scores are reported as percentages of this maximum.) Eurasian watermilfoil and musk grass recorded a dominance of 4.0. All other species were relatively sparse throughout the entire sampled water column, with coontail possessing a dominance of 2.5, and slender naiad a dominance of 1.5. All other species had dominances of 1. Filamentous algae were also present at 55% of sites; however, densities are not assigned to this species. Maps detailing other species locations are included in Appendix B.

**Table C. Frequency and dominance of submerged aquatic plant species identified during the Tier II survey of Diamond Lake conducted August 27, 2007.**

| **Occurrence and abundance of submersed aquatic plants in Diamond Lake.** | | | | | |
|---|---|---|---|---|---|
| Total Sites: | 40 | Mean species / site: | 1.03 | Native diversity: | 0.81 |
| Littoral Sites: | 30 | Maximum species / site: | 5 | Species diversity: | 0.83 |
| Littoral Depth (ft): | 9 | Number of species: | 11 | SE Mean natives / site: | 0.22 |
| Date: | 8/27/07 | Littoral sites with plants: | 17 | Mean natives / site: | 0.93 |
| Lake: | Diamond | Secchi(ft): | 3.5 | SE Mean species / site: | 0.24 |

| **All depths (0-15')** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Najas guadalupensis* | Southern naiad | 35.00 | 65.00 | 32.50 | 0.00 | 2.50 | 9.00 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 10.00 | 90.00 | 5.00 | 5.00 | 0.00 | 4.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Chara* species | Chara species | 10.00 | 90.00 | 5.00 | 5.00 | 0.00 | 4.00 |
| *Stuckenia pectinatus* | Sago pondweed | 10.00 | 90.00 | 10.00 | 0.00 | 0.00 | 2.00 |
| *Najas flexilis* | Slender naiad | 7.50 | 92.50 | 7.50 | 0.00 | 0.00 | 1.50 |
| *Ceratophyllum demersum* | Coontail | 7.50 | 92.50 | 5.00 | 2.50 | 0.00 | 2.50 |
| *Potamogeton gramineus* | Grassy pondweed | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Myriophyllum exalbescens* | Northern water milfoil | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Elodea canadensis* | Common water weed | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Potamogeton illinoensis* | Illinois pondweed | 2.50 | 97.50 | 0.00 | 2.50 | 0.00 | 1.50 |
| *Filamentous algae* | Filamentous algae | 55.00 | | | | | |

| **0-5' Stratum** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Najas guadalupensis* | Southern naiad | 61.54 | 38.46 | 61.54 | 0.00 | 0.00 | 12.31 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 23.08 | 76.92 | 7.69 | 15.38 | 0.00 | 10.77 |
| *Chara* species | Chara species | 23.08 | 76.92 | 15.38 | 7.69 | 0.00 | 7.69 |
| *Stuckenia pectinatus* | Sago pondweed | 23.08 | 76.92 | 23.08 | 0.00 | 0.00 | 4.62 |
| *Najas flexilis* | Slender naiad | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Myriophyllum exalbescens* | Northern water milfoil | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Elodea canadensis* | Common water weed | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Potamogeton illinoensis* | Illinois pondweed | 7.69 | 92.31 | 0.00 | 7.69 | 0.00 | 4.62 |
| *Potamogeton gramineus* | Grassy pondweed | 7.69 | 92.31 | 7.69 | 0.00 | 0.00 | 1.54 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7.69 | 92.31 | 7.69 | 0.00 | 0.00 | 1.54 |
| *Ceratophyllum demersum* | Coontail | 7.69 | 92.31 | 7.69 | 0.00 | 0.00 | 1.54 |
| *Filamentous algae* | Filamentous algae | 53.85 | | | | | |

| **5-10' Stratum** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Najas guadalupensis* | Southern naiad | 31.58 | 68.42 | 26.32 | 0.00 | 5.26 | 10.53 |
| *Ceratophyllum demersum* | Coontail | 10.53 | 89.47 | 5.26 | 5.26 | 0.00 | 4.21 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Potamogeton gramineus* | Grassy pondweed | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Najas flexilis* | Slender naiad | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Chara* species | Chara species | 5.26 | 94.74 | 0.00 | 5.26 | 0.00 | 3.16 |
| *Stuckenia pectinatus* | Sago pondweed | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Filamentous algae* | Filamentous algae | 68.42 | | | | | |

| **10-15' Stratum** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Filamentous algae* | Filamentous algae | 25.00 | | | | | |

Southern naiad also dominated the submerged plant community in the 0-5 foot and 5-10 foot strata (Table C). Southern naiad was the most frequent as it was found at 61.5% of the sites in the 0-5 foot stratum and 31.6% of the sites in the 5-10 foot stratum. Southern naiad generated the highest dominance rating of 12.3 in the 0-5 foot stratum and 10.5 in the 5-10 foot stratum. Eurasian watermilfoil, musk grass, and sago pondweed were each found at 23% of the sites in the 0-5 foot stratum. These species had dominances of 10.8, 7.7, and 4.6, respectively. Eurasian watermilfoil was observed at only 5.3% of the sites in the 5-10 foot stratum with a dominance of 1.05. Eurasian watermilfoil was not identified in the 10-15 foot stratum of Diamond Lake. Overall, Eurasian watermilfoil was identified at 10% of the sampled sites throughout the lake (Figure C).

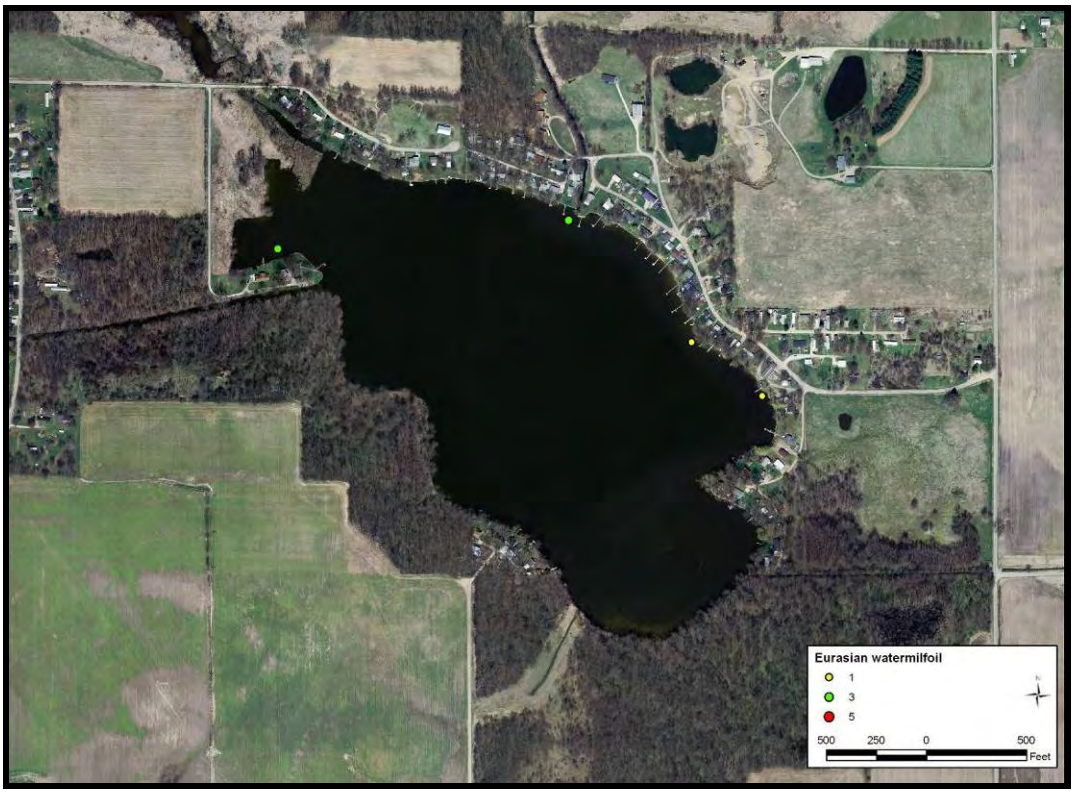



**Figure C. Location and density of Eurasian watermilfoil identified in Diamond Lake during the August 27, 2007 Tier II survey.**

**Hill Lake**

*Inventory*

Transparency was found to be 8.5 feet in Hill Lake during the Tier II survey. Hill Lake's plant community extends from the lake's shoreline to water that is 14 feet (4.3 m) deep. In total, 23 aquatic plant species inhabit the water and shoreline of Hill Lake (Table D). The LARE protocol used to conduct the aquatic plant survey requires surveyors to note all plant species observed from a boat. Thus, plants in the wetland complexes adjacent to the lake were only counted if they were visible from the boat. If these wetland complexes had been explored in greater detail, it is likely that the total number of plant species would increase significantly.

**Table D. Plant species observed in Hill Lake as identified on August 27, 2007.**

| Scientific Name | Common Name | Stratum |
|---|---|---|
| *Asclepias incarnata* | Swamp milkweed | Emergent |
| *Ceratophyllum demersum* | Coontail | Submergent |
| *Chara* species | Musk grass species | Submergent |
| *Decodon verticillatus* | Whirled loosestrife | Emergent |
| *Elodea canadensis* | Common waterweed | Submergent |
| *Filamentous algae* | Filamentous algae | Algae |
| *Myriophyllum exalbescens* | Northern watermilfoil | Submergent |
| *Myriophyllum heterophyllum* | Variable-leaf watermilfoil | Submergent |

| | | |
|---|---|---|
| *Myriophyllum spicatum* | Eurasian watermilfoil | Submergent |
| *Najas guadalupensis* | Southern naiad | Submergent |
| *Nuphar advena* | Spatterdock | Floating |
| *Nuphar variagatum* | Yellow pond lily | Floating |
| *Nymphaea tuberosa* | White water lily | Floating |
| *Polygonum coccineum* | Water heartsease | Emergent |
| *Polygonum lapathifolium* | Willow-weed | Emergent |
| *Pontederia cordata* | Pickerel weed | Emergent |
| *Potamogeton amplifolius* | Large-leaf pondweed | Submergent |
| *Scirpus acutus* | Hard-stem bulrush | Emergent |
| *Scirpus pungens* | Chairmaker's rush | Emergent |
| *Stuckenia pectinatus* | Sago pondweed | Submergent |
| *Typha angustifolia* | Narrow-leaf cattail | Emergent |
| *Typha* x *glauca* | Blue cattail | Emergent |
| *Typha latifolia* | Broad-leaf cattail | Emergent |

Of the 23 species observed in Hill Lake, nine species were submerged plant species. Of the nine submerged species, nearly all of those are adapted to high nutrient environments. Only two of the submerged species were pondweeds (i.e. belonging to the *Potamogeton* genus), which along with northern watermilfoil are typically adapted to better water quality conditions. However, both species were identified in relatively low density. Compared to other lakes in the region, this diversity of submerged species represents relatively low species richness for the submerged strata. Coontail, Eurasian watermilfoil, and musk grass dominated the submerged plant community and were observed throughout the lake. Only one exotic species, Eurasian watermilfoil was identified within or adjacent to Hill Lake.

The species richness of the emergent strata was similar to the submerged strata, while the floating strata's richness was much lower than the emergent and submerged strata. Ten (10) emergent species were noted bordering Hill Lake's edges, while only three floating species were observed in the lake. (It is important to note that there are significantly fewer floating aquatic species that are native to Indiana lakes compared to the number of emergent and submerged species. Consequently, many lakes possess low numbers of floating species.) The most common emergent species include reed canary grass, whirled loosestrife, and cattails including narrow-leaf, broad-leaf, and blue cattail. The most common floating species are spatterdock, white water lily, and duckweed.

*Tier II*

During the Tier II survey, coontail dominated the plant community over all depths (0-15 feet; Table E). (Appendix A details raw data collected during the Tier II aquatic plant survey.) This species was found at the highest percentage of sites throughout the entire sampled water column (56%) and also had the highest relative density (1.44). Throughout the entire sampled water column, other species were relatively frequent with Eurasian watermilfoil present at 36% of the sites and musk grass present at 20% of the sites. Sago pondweed and northern watermilfoil were each found at 15.4% of the sites. With regards to dominance, coontail dominated the submerged plant community throughout the entire sampled water column with a dominance of 29. (A dominance of 200

represents a perfect score or the highest dominance possible within Hill Lake. This results from multiplying the highest density score (5) by the number of sites where plants were sampled (40). Dominance scores are reported as percentages of this maximum.) All other species were relatively sparse throughout the entire sampled water column, with Eurasian watermilfoil possessing a dominance of 18.5; musk grass a dominance of 14.4; and sago pondweed, northern watermilfoil, and southern naiad each having a dominance of 3. All other species had dominances of 1 or less. Filamentous algae were also present at 5.1% of the sites; however, densities are not assigned to this species. Maps detailing other species locations are included in Appendix B.

**Table E. Frequency and dominance of submerged aquatic plant species identified during the Tier II survey of Hill Lake conducted August 27, 2007.**

| Occurrence and abundance of submersed aquatic plant species in Hill Lake. | | | | | |
|---|---|---|---|---|---|
| Total Sites: | 39 | Mean species / site: | 1.64 | Native diversity: | 0.74 |
| Littoral Sites: | 35 | Maximum species / site: | 5 | Species diversity: | 0.80 |
| Littoral Depth (ft): | 14 | Number of species: | 9 | SE Mean natives / site: | 0.18 |
| Date: | 8/27/07 | Littoral sites with plants: | 29 | Mean natives / site: | 1.28 |
| Lake: | Hill | Secchi(ft): | 8.5 | SE Mean species / site: | 0.23 |

| **All depths (0-15')** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Ceratophyllum demersum* | Coontail | 56.41 | 43.59 | 23.08 | 23.08 | 10.26 | 28.72 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 35.90 | 64.10 | 17.95 | 7.69 | 10.26 | 18.46 |
| *Chara* species | Chara species | 20.51 | 79.49 | 5.13 | 5.13 | 10.26 | 14.36 |
| *Stuckenia pectinatus* | Sago pondweed | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Myriophyllum exalbescens* | Northern watermilfoil | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Najas guadalupensis* | Southern naiad | 10.26 | 89.74 | 7.69 | 2.56 | 0.00 | 3.08 |
| *Myriophyllum heterophyllum* | Variable-leaf watermilfoil | 5.13 | 94.87 | 5.13 | 0.00 | 0.00 | 1.03 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 2.56 | 97.44 | 2.56 | 0.00 | 0.00 | 0.51 |
| *Elodea canadensis* | Common water weed | 2.56 | 97.44 | 2.56 | 0.00 | 0.00 | 0.51 |
| *Filamentous algae* | Filamentous algae | 5.13 | | | | | |

| **0-5' Stratum** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Chara* species | Chara species | 60.00 | 40.00 | 0.00 | 20.00 | 40.00 | 52.00 |
| *Ceratophyllum demersum* | Coontail | 50.00 | 50.00 | 30.00 | 10.00 | 10.00 | 22.00 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 40.00 | 60.00 | 30.00 | 0.00 | 10.00 | 16.00 |
| *Stuckenia pectinatus* | Sago pondweed | 30.00 | 70.00 | 30.00 | 0.00 | 0.00 | 6.00 |
| *Najas guadalupensis* | Southern naiad | 20.00 | 80.00 | 10.00 | 10.00 | 0.00 | 8.00 |
| *Myriophyllum exalbescens* | Northern watermilfoil | 20.00 | 80.00 | 20.00 | 0.00 | 0.00 | 4.00 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 10.00 | 90.00 | 10.00 | 0.00 | 0.00 | 2.00 |

| **5-10' Stratum** | | **Frequency of Occurrence** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | | **0** | **1** | **3** | **5** | **Dominance** |
| *Ceratophyllum demersum* | Coontail | 78.57 | 21.43 | 35.71 | 28.57 | 14.29 | 38.57 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 57.14 | 42.86 | 21.43 | 21.43 | 14.29 | 31.43 |
| *Myriophyllum exalbescens* | Northern watermilfoil | 28.57 | 71.43 | 28.57 | 0.00 | 0.00 | 5.71 |
| *Stuckenia pectinatus* | Sago pondweed | 21.43 | 78.57 | 21.43 | 0.00 | 0.00 | 4.29 |
| *Najas guadalupensis* | Southern naiad | 14.29 | 85.71 | 14.29 | 0.00 | 0.00 | 2.86 |
| *Myriophyllum heterophyllum* | Variable-leaf watermilfoil | 14.29 | 85.71 | 14.29 | 0.00 | 0.00 | 2.86 |
| *Chara* species | Chara species | 14.29 | 85.71 | 14.29 | 0.00 | 0.00 | 2.86 |
| *Elodea canadensis* | Common water weed | 7.14 | 92.86 | 7.14 | 0.00 | 0.00 | 1.43 |
| *Filamentous algae* | Filamentous algae | 14.29 | | | | | |

| 10-15' Stratum | | Frequency of Occurrence | Frequency per Species | | | | |
|---|---|---|---|---|---|---|---|
| Scientific Name | Common Name | | 0 | 1 | 3 | 5 | Dominance |
| *Ceratophyllum demersum* | Coontail | 54.55 | 45.45 | 9.09 | 36.36 | 9.09 | 32.73 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 18.18 | 81.82 | 9.09 | 0.00 | 9.09 | 10.91 |

Coontail also dominated the submerged plant community in the 0-5 foot, 5-10 foot, and 10-15 foot strata (Table E). Coontail was the second most frequent as it was found at 50% of the sites in the 0-5 foot stratum and musk grass was found at 60% of the sites. Coontail was the most frequent and was found at 78.6% of the sites in the 5-10 foot stratum and at 54.6% of the sites in the 10-15 foot stratum. Musk grass generated the highest dominance rating of 52 in the 0-5 foot stratum, while coontail generated a dominance of 22. Coontail generated the highest dominance rating of 38.6 in the 5-10 foot stratum and 32.7 in the 10-15 foot stratum. Eurasian watermilfoil was also very frequent and somewhat dominant. This species was identified at 40%, 57%, and 18% of the sites in the 0-5 foot, 5-10 foot, and 10-15 foot strata, respectively. No plants were found in the 15-20 foot stratum. Both frequency and density of Eurasian watermilfoil increased in the 5-10 foot stratum. Overall, Eurasian watermilfoil was identified at 35.9% of the sampled sites throughout the lake (Figure E).

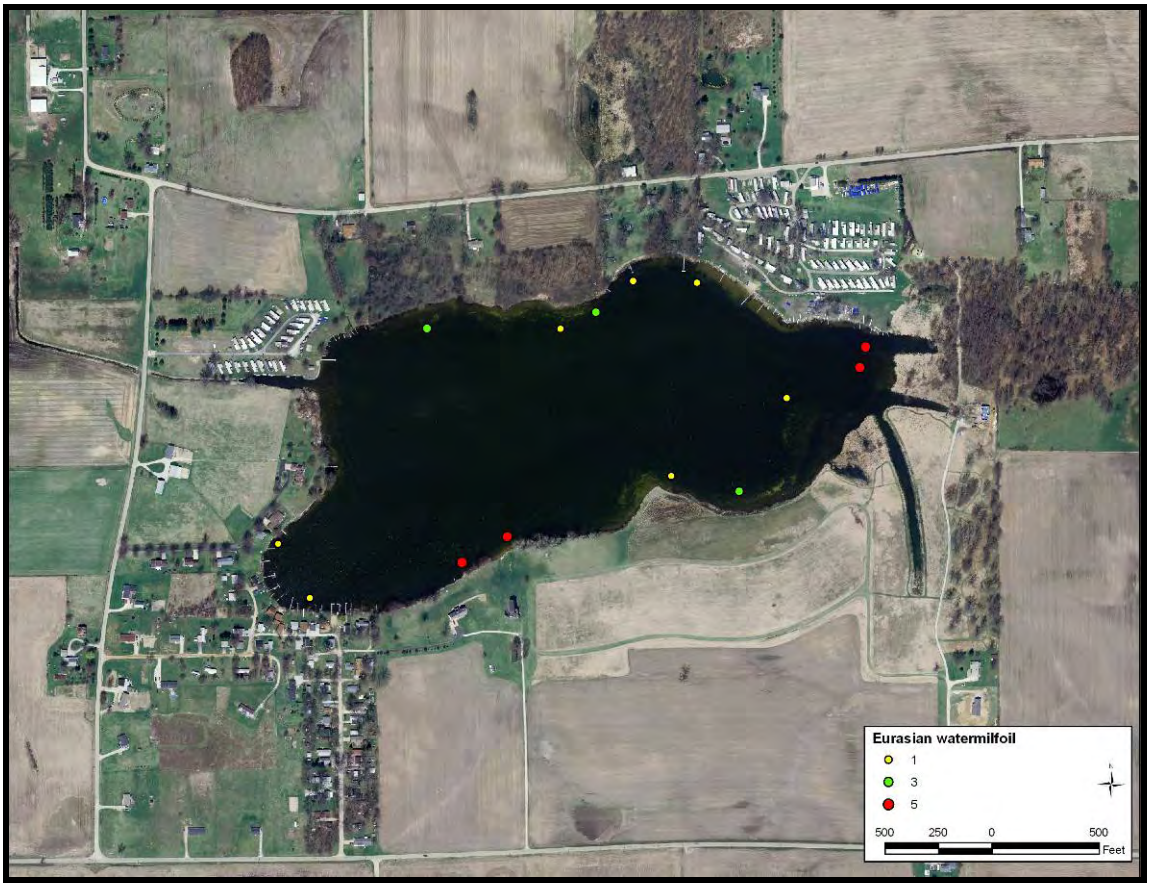



**Figure E. Location and density of Eurasian watermilfoil identified in Hill Lake during the August 27, 2007 Tier II survey.**

**Current and Historic Data Comparison**

When recently collected data is compared with data reported by Pearson (2004), in general Diamond Lake possesses greater diversity than the lakes surveyed by Pearson (Table F). Diamond Lake possessed higher numbers of native species and numbers of species overall during the summer 2007 survey than those identified on average in Pearson's study. Diamond Lake also possessed greater rake diversity, greater native rake diversity, and greater native and overall species richness than those recorded during Pearson's survey.

**Table F. A comparison of the pre- and post-treatment aquatic plant communities in Diamond and Hill lakes to the average values for plant community metrics found by Pearson (2004) in his survey of 21 northern Indiana lakes. Bolding indicates that the value exceeds Pearson average.**

| Metric | Diamond Lake | | | | | | | Hill Lake | Indiana Average |
|---|---|---|---|---|---|---|---|---|---|
| | 5/25 2005 | 7/25 2005 | 5/24 2006 | 8/4 2006 | 6/12 2007 | 8/2 2007 | 8/27 2007 | 8/27 2007 | |
| Number of species collected | **11** | **12** | **9** | **11** | **10** | **11** | **11** | **9** | 8 |
| Number of native species | **8** | **10** | 7 | **10** | 7 | **9** | **10** | **8** | 7 |
| Species Richness | **1.85** | **1.86** | 0.83 | 0.81 | 0.61 | **1.00** | **1.03** | **1.64** | 0.66 |
| Native Species Richness | **1.12** | **1.75** | 0.76 | 0.77 | 0.46 | **0.93** | **0.93** | **1.28** | 0.56 |
| Rake Diversity | 0.22 | 0.22 | **0.98** | **1.08** | 0.61 | **1.00** | **0.83** | **0.80** | 0.62 |
| Native Rake Diversity | 0.13 | 0.21 | **0.80** | **0.78** | 0.46 | **0.93** | **0.81** | **0.74** | 0.5 |

Sources: Edgell, R.A. 2006, 2007; IDNR, 2006.

**Macrophyte Inventory Discussion**

Since we cannot account for all the spatial variables impacting the plant community, such as boat-traffic and changes in nutrient availability, or for temporal variables like climactic conditions, including temperature and precipitation levels, an exact and precise analysis regarding the impact of herbicide treatment upon the Diamond Lake aquatic plant community is not possible. Still, general trends emerge from the data that are useful for the purpose of management decisions. When the 2005 to 2007 data are compared, decrease in spring Eurasian watermilfoil frequencies were observed in Diamond Lake. The frequency of Eurasian watermilfoil in 2005 is nearly 10 times that observed in 2006 and 2007. Data suggest declines in Eurasian watermilfoil frequency and density from 2005 to 2006; both frequency and density held steady from 2006 to 2007. Similar patterns are apparent with relation to spring and summer frequency and density in 2005 and 2006; however, no change was apparent in 2007 (Table G).

**Table G. Variation in site frequency, relative and mean density, and dominance of Eurasian watermilfoil in Diamond Lake from 2005 to 2007.**

| Common Name | Date | Site Frequency | Relative Density | Mean Density | Dominance |
|---|---|---|---|---|---|
| Diamond Lake | 5/25/05 | 47.4 | 0.80 | 1.7 | 16.49 |
| | 7/25/05 | 1.7 | 0.02 | 1.0 | 0.34 |
| | 5/24/06 | 5.0 | 0.0 | 0.0 | 1.0 |
| | 8/4/06 | 2.5 | 0.0 | 0.0 | 0.5 |
| | 6/12/07 | 4.9 | 0.05 | 1.0 | 1.0 |
| | 8/2/07 | 7.5 | 0.10 | 1.7 | 2.5 |
| | 8/27/07 | 10.0 | 0.20 | 2.0 | 4.0 |
| Hill Lake | 8/27/07 | 35.9 | 0.92 | 2.57 | 18.5 |

Sources: Edgell, R.A. 2006, 2007; IDNR, 2006.

No historic data has been collected at Hill Lake; therefore, a comparison of current and historic data is not possible at this time.

## Plant Management History

### Diamond Lake

On June 22, 2006, Weed Patrol Inc. treated a total of 18 acres of Eurasian watermilfoil and filamentous algae in Diamond Lake. On July 19, 2006, Weed Patrol, Inc. treated 5 acres of Eurasian watermilfoil. In total, 23 acres of Eurasian watermilfoil and 18 acres of filamentous algae were treated in 2006. For selective Eurasian watermilfoil control, roughly 2 ppm of Aquathol K (approximately 1 gallon per acre depending on the depth and size of the area) was applied. On June 9, 2005, Weed Patrol, Inc. treated a total of 18 acres of filamentous algae, curly-leaf pondweed, and Eurasian watermilfoil. For curly-leaf pondweed control, 0.5 mg/L of Aquathol K herbicide was used (applied at a rate of approximately 1 gallon per acre). This low rate was used to control curly-leaf pondweed, which is more sensitive to Aquathol K, while not killing native pondweeds (Tony Cunningham, Weed Patrol, personal communication). For all treatments, herbicide was applied by making narrow passes through the treatment area. Filamentous algae were treated with copper sulfate at a rate of 2.6 lb/acre-foot.

### Hill Lake

There are no records of prior treatment on Hill Lake.

## Recommendations

Future (2008) recommendations are based on information from informal surveys completed by Aquatic Weed Control, the 2007 survey JFNew completed, and the permit meeting attended by the IDNR LARE program staff, district fisheries biologist, Aquatic Weed Control, and JFNew on November 9, 2007. These recommendations include a combination, early-season treatment targeting curly-leaf pondweed and Eurasian watermilfoil in Diamond Lake in 2008. Treatment targets these species which cover nearly 18 acres of Diamond Lake's shoreline with 2,4-D and Aquathol K (Figure F). For treatment to continue within the lake, Diamond Lake also needs to update their aquatic plant management plan. This process should include a pre-treatment exotic species survey, a pre-treatment Tier II survey, a post-treatment exotic species survey, a post-treatment Tier II survey, a public meeting, a meeting with the DNR (LARE staff and district fisheries biologist), and development of a revised aquatic plant management plan. It is imperative that the pre-treatment

survey occur prior to any treatment of curly-leaf pondweed or Eurasian watermilfoil. Chemical rates will generally be low (approximately 1 mg/L) and should occur prior to water temperatures reaching 56 degrees F.

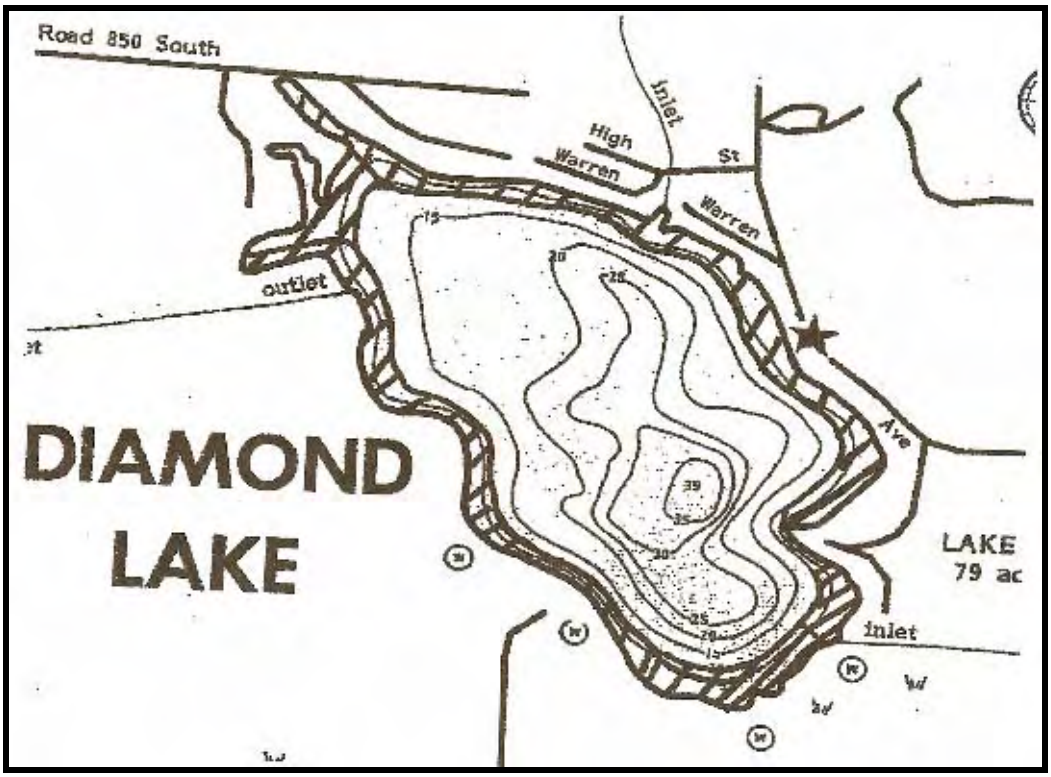



**Figure F. Proposed 2008 treatment area within Diamond Lake.**

Additionally, for long-term control of Eurasian watermilfoil within Diamond Lake, the Diamond Lake Conservation Club should partner with residents at Hill Lake to treat the Eurasian watermilfoil population present within Hill Lake. Eurasian watermilfoil spreads by fragmentation. As much of Hill Lake's shoreline is vegetated by relatively dense Eurasian watermilfoil, it provides a source of this plant to lakes downstream. As Eurasian watermilfoil spreads by fragmentation, any pieces that are cut from plants within Hill Lake can pass through the drainage ditch connecting Hill Lake to Diamond Lake. If treatment of Eurasian watermilfoil within Hill Lake does not occur, Hill Lake's Eurasian watermilfoil community will continue to re-seed Diamond Lake. Therefore, if Hill Lake's Eurasian watermilfoil community is not treated, then Eurasian watermilfoil will not be reduced or eliminated within Diamond Lake no matter DLCC's level of effort.

At a minimum, treatment of Eurasian watermilfoil along the shoreline of Hill Lake should occur within Hill Lake. Spot treatments would target the Eurasian watermilfoil population throughout the lake; however, spot treatments must continue for several years in order to reduce the density and dominance of Eurasian watermilfoil within Hill Lake. It is estimated that spot treatment of approximately 20 acres of Hill Lake will cost approximately $8,000. Alternately, Hill Lake is a good candidate for a whole-lake treatment targeting Eurasian watermilfoil. Hill Lake is a headwater's lake. As such, its watershed is relatively small and the amount of time that water spends in the lake is relatively long. Both of these factors increase the likelihood that a whole lake treatment would be effective as fluridone (the chemical used for whole lake treatments) must remain at a certain

concentration for a long period of time. Outflow can increase the cost and reduce the effectiveness of fluridone treatments. If whole lake treatment is selected, the fluridone treatment should be completed with the goal of achieving an initial concentration of 6 ppb (μg/L). The concentration should remain above 3 ppb for 90 days. FasTests will be necessary to determine if the recommended concentration is reached and maintained within Hill Lake. In total, a test should occur within two locations within three days of initial treatment to ascertain the initial concentration. Subsequent tests should occur every three weeks for 90 days after the initial target concentration is reached. Bump treatments may be necessary in order to maintain the target concentration. It is estimated that a whole lake treatment with fluridone will cost approximately $18,000. Based on these options, it is likely that continuous spot treatment of Eurasian watermilfoil within Hill Lake will likely cost more in the long-run than one whole lake treatment. The selected treatment methodology will be determined prior to treatment occurring in 2008. The decision-making process should include the district fisheries biologist, Diamond Lake Conservation Club members, and Hill Lake residents.

**Project Budget**

Costs for aquatic plant assessment and treatment for Diamond Lake in 2008 are as follows:

- Eurasian watermilfoil and curly-leaf pondweed treatment at Diamond Lake of approximately 18 acres with granular 2,4-D and Aquathol K for a total cost of $7,000.
- Standard LARE assessment, public meeting, and plan revision costs are based on 2007 LARE requirements (pre-treatment exotic species distribution survey; pre- and post-treatment Tier II surveys; public meeting; plan revision). Assessment of Diamond Lake's plant community and plan revision is anticipated to occur at a cost of $7,500.

Costs for aquatic plant assessment and treatment for Hill Lake in 2008 are as follows:

- Eurasian watermilfoil treatment at Hill Lake of approximately 20 acres with granular 2,4-D at a cost of $375 per acre for a total cost of $7,500, or whole-lake treatment at Hill Lake with fluridone at 6 ppb for a cost of $18,000.
- Standard LARE assessment, public meeting, and plan revision costs are based on 2007 LARE requirements (pre-treatment exotic species distribution survey; one post-treatment Tier II survey; public meeting; plan revision). Assessment of Hill Lake's plant community and plan creation is anticipated to occur in concert with Diamond Lake's plan revision and requires no additional cost.

Total fees for 2008 aquatic plant assessment for Diamond and Hill lakes, herbicide application, and plan updated are estimated at $22,500 if spot treatment within Hill Lake occurs or cost $33,000 if a whole-lake treatment occurs in Hill Lake. All of these monies require a 10% match.

The following time schedule is anticipated for aquatic plant management activities for Diamond and Hill lakes in 2008:

| | |
|---|---|
| May 15-June 15, 2008 | Pre-treatment/spring Tier II survey; Approximate Eurasian watermilfoil treatment |
| July 15-August 30, 2008 | Tier II post-treatment/summer assessment |
| August-October, 2008 | Public meeting |
| November 2008 | Meeting between IDNR LARE and fisheries staff, lake associations, and contractor |
| December 15, 2008 | Plan revision |
| January 15, 2009 | LARE application for 2009 funding due |

## References Cited

Meyer, C. 2006. 2005 Fish Management Report. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Edgell, R.A. 2006. Supplemental Evaluation, Diamond Lake, Kosciusko County, Indiana.

Indiana Department of Natural Resources. 2007. Tier II aquatic vegetation survey protocol. Indianapolis, Indiana.

IDNR, 2007. Unpublished data.

Pearson, J. 2004. A sampling method to assess occurrence, abundance and distribution of submersed aquatic plants in Indiana lakes. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

# APPENDIX A:

# TIER II SURVEY RAW DATA

## DIAMOND AND HILL LAKES
## AQUATIC PLANT MANAGEMENT PLAN REVISION 2007
## EXCERPT FROM YELLOW CREEK LAKES DIAGNOSTIC STUDY

**Occurrence and abundance of submersed aquatic plants in Diamond Lake.**

| | | | | | |
|---|---|---|---|---|---|
| Total Sites: | 40 | Mean species / site: | 1.03 | Native diversity: | 0.81 |
| Littoral Sites: | 30 | Maximum species / site: | 5 | Species diversity: | 0.83 |
| Littoral Depth (ft): | 9 | Number of species: | 11 | SE Mean natives / site: | 0.22 |
| Date: | 8/27/07 | Littoral sites with plants: | 17 | Mean natives / site: | 0.93 |
| Lake: | Diamond | Secchi(ft): | 3.5 | SE Mean species / site: | 0.24 |

| **All depths (0-15')** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Najas guadalupensis* | Southern naiad | 35.00 | 65.00 | 32.50 | 0.00 | 2.50 | 9.00 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 10.00 | 90.00 | 5.00 | 5.00 | 0.00 | 4.00 |
| *Chara* species | Chara species | 10.00 | 90.00 | 5.00 | 5.00 | 0.00 | 4.00 |
| *Stuckenia pectinatus* | Sago pondweed | 10.00 | 90.00 | 10.00 | 0.00 | 0.00 | 2.00 |
| *Najas flexilis* | Slender naiad | 7.50 | 92.50 | 7.50 | 0.00 | 0.00 | 1.50 |
| *Ceratophyllum demersum* | Coontail | 7.50 | 92.50 | 5.00 | 2.50 | 0.00 | 2.50 |
| *Potamogeton gramineus* | Grassy pondweed | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Myriophyllum exalbescens* | Northern water milfoil | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Elodea canadensis* | Common water weed | 5.00 | 95.00 | 5.00 | 0.00 | 0.00 | 1.00 |
| *Potamogeton illinoensis* | Illinois pondweed | 2.50 | 97.50 | 0.00 | 2.50 | 0.00 | 1.50 |
| *Filamentous algae* | Filamentous algae | 55.00 | | | | | |

| **0-5' Stratum** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Najas guadalupensis* | Southern naiad | 61.54 | 38.46 | 61.54 | 0.00 | 0.00 | 12.31 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 23.08 | 76.92 | 7.69 | 15.38 | 0.00 | 10.77 |
| *Chara* species | Chara species | 23.08 | 76.92 | 15.38 | 7.69 | 0.00 | 7.69 |
| *Stuckenia pectinatus* | Sago pondweed | 23.08 | 76.92 | 23.08 | 0.00 | 0.00 | 4.62 |
| *Najas flexilis* | Slender naiad | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Myriophyllum exalbescens* | Northern water milfoil | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Elodea canadensis* | Common water weed | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Potamogeton illinoensis* | Illinois pondweed | 7.69 | 92.31 | 0.00 | 7.69 | 0.00 | 4.62 |
| *Potamogeton gramineus* | Grassy pondweed | 7.69 | 92.31 | 7.69 | 0.00 | 0.00 | 1.54 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7.69 | 92.31 | 7.69 | 0.00 | 0.00 | 1.54 |
| *Ceratophyllum demersum* | Coontail | 7.69 | 92.31 | 7.69 | 0.00 | 0.00 | 1.54 |
| *Filamentous algae* | Filamentous algae | 53.85 | | | | | |

| **5-10' Stratum** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Najas guadalupensis* | Southern naiad | 31.58 | 68.42 | 26.32 | 0.00 | 5.26 | 10.53 |
| *Ceratophyllum demersum* | Coontail | 10.53 | 89.47 | 5.26 | 5.26 | 0.00 | 4.21 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Potamogeton gramineus* | Grassy pondweed | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Najas flexilis* | Slender naiad | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Chara* species | Chara species | 5.26 | 94.74 | 0.00 | 5.26 | 0.00 | 3.16 |
| *Stuckenia pectinatus* | Sago pondweed | 5.26 | 94.74 | 5.26 | 0.00 | 0.00 | 1.05 |
| *Filamentous algae* | Filamentous algae | 68.42 | | | | | |

| **10-15' Stratum** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Filamentous algae* | Filamentous algae | 25.00 | | | | | |

**Occurrence and abundance of submersed aquatic plant species in Hill Lake.**

| | | | | | |
|---|---|---|---|---|---|
| Total Sites: | 39 | Mean species / site: | 1.64 | Native diversity: | 0.74 |
| Littoral Sites: | 35 | Maximum species / site: | 5 | Species diversity: | 0.80 |
| Littoral Depth (ft): | 14 | Number of species: | 9 | SE Mean natives / site: | 0.18 |
| Date: | 8/27/07 | Littoral sites with plants: | 29 | Mean natives / site: | 1.28 |
| Lake: | Hill | Secchi(ft): | 8.5 | SE Mean species / site: | 0.23 |

| **All depths (0-15')** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Ceratophyllum demersum* | Coontail | 56.41 | 43.59 | 23.08 | 23.08 | 10.26 | 28.72 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 35.90 | 64.10 | 17.95 | 7.69 | 10.26 | 18.46 |
| *Chara* species | Chara species | 20.51 | 79.49 | 5.13 | 5.13 | 10.26 | 14.36 |
| *Stuckenia pectinatus* | Sago pondweed | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Myriophyllum exalbescens* | Northern watermilfoil | 15.38 | 84.62 | 15.38 | 0.00 | 0.00 | 3.08 |
| *Najas guadalupensis* | Southern naiad | 10.26 | 89.74 | 7.69 | 2.56 | 0.00 | 3.08 |
| *Myriophyllum heterophyllum* | Variable-leaf watermilfoil | 5.13 | 94.87 | 5.13 | 0.00 | 0.00 | 1.03 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 2.56 | 97.44 | 2.56 | 0.00 | 0.00 | 0.51 |
| *Elodea canadensis* | Common water weed | 2.56 | 97.44 | 2.56 | 0.00 | 0.00 | 0.51 |
| *Filamentous algae* | Filamentous algae | 5.13 | | | | | |

| **0-5' Stratum** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Chara* species | Chara species | 60.00 | 40.00 | 0.00 | 20.00 | 40.00 | 52.00 |
| *Ceratophyllum demersum* | Coontail | 50.00 | 50.00 | 30.00 | 10.00 | 10.00 | 22.00 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 40.00 | 60.00 | 30.00 | 0.00 | 10.00 | 16.00 |
| *Stuckenia pectinatus* | Sago pondweed | 30.00 | 70.00 | 30.00 | 0.00 | 0.00 | 6.00 |
| *Najas guadalupensis* | Southern naiad | 20.00 | 80.00 | 10.00 | 10.00 | 0.00 | 8.00 |
| *Myriophyllum exalbescens* | Northern watermilfoil | 20.00 | 80.00 | 20.00 | 0.00 | 0.00 | 4.00 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 10.00 | 90.00 | 10.00 | 0.00 | 0.00 | 2.00 |

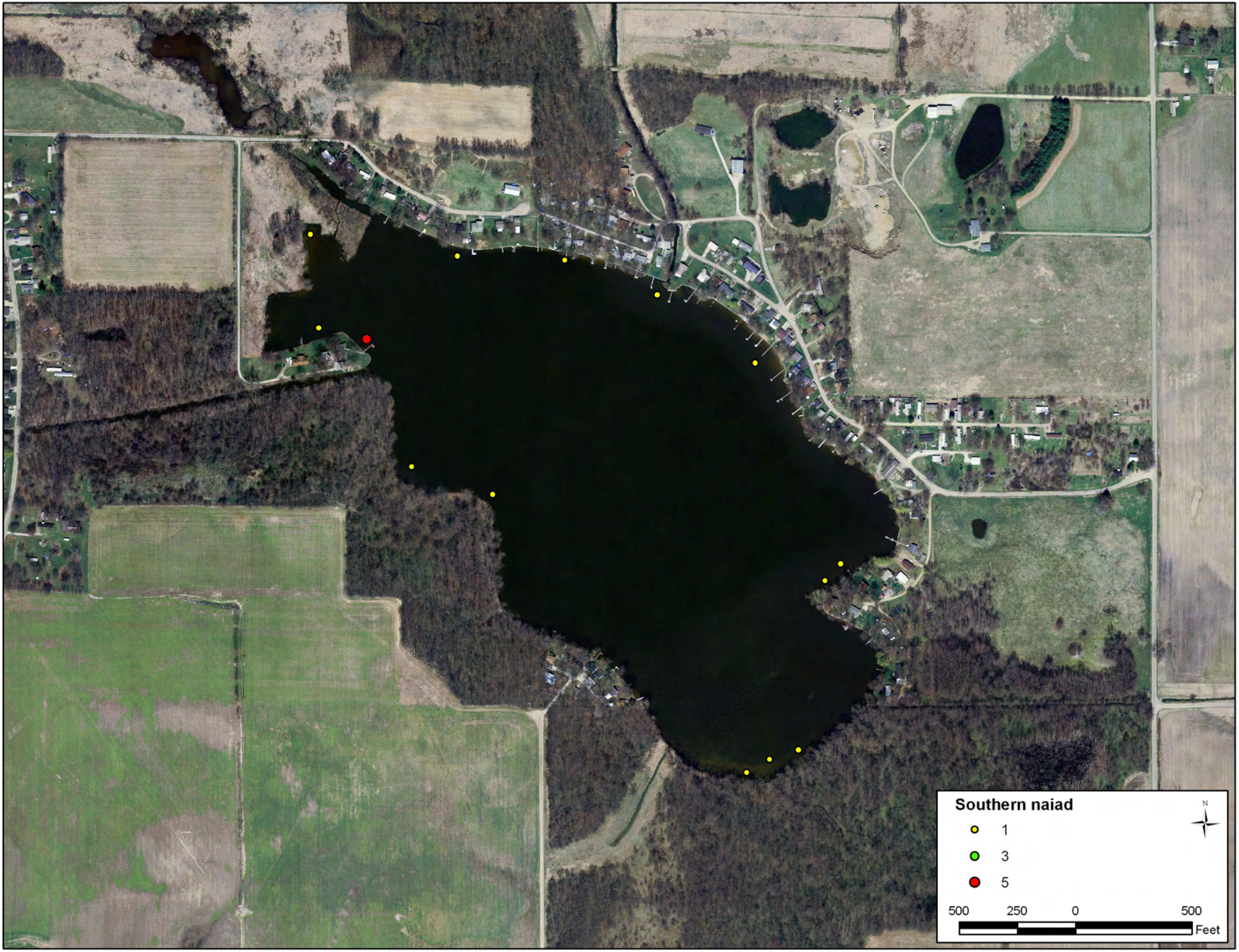
| **5-10' Stratum** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Ceratophyllum demersum* | Coontail | 78.57 | 21.43 | 35.71 | 28.57 | 14.29 | 38.57 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 57.14 | 42.86 | 21.43 | 21.43 | 14.29 | 31.43 |
| *Myriophyllum exalbescens* | Northern watermilfoil | 28.57 | 71.43 | 28.57 | 0.00 | 0.00 | 5.71 |
| *Stuckenia pectinatus* | Sago pondweed | 21.43 | 78.57 | 21.43 | 0.00 | 0.00 | 4.29 |
| *Najas guadalupensis* | Southern naiad | 14.29 | 85.71 | 14.29 | 0.00 | 0.00 | 2.86 |
| *Myriophyllum heterophyllum* | Variable-leaf watermilfoil | 14.29 | 85.71 | 14.29 | 0.00 | 0.00 | 2.86 |
| *Chara* species | Chara species | 14.29 | 85.71 | 14.29 | 0.00 | 0.00 | 2.86 |
| *Elodea canadensis* | Common water weed | 7.14 | 92.86 | 7.14 | 0.00 | 0.00 | 1.43 |
| *Filamentous algae* | Filamentous algae | 14.29 | | | | | |

| **10-15' Stratum** | | **Frequency of** | **Frequency per Species** | | | | |
|---|---|---|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| *Ceratophyllum demersum* | Coontail | 54.55 | 45.45 | 9.09 | 36.36 | 9.09 | 32.73 |
| *Myriophyllum spicatum* | Eurasian watermilfoil | 18.18 | 81.82 | 9.09 | 0.00 | 9.09 | 10.91 |

# APPENDIX B:

# FIGURES

## DIAMOND AND HILL LAKES
## AQUATIC PLANT MANAGEMENT PLAN REVISION 2007
## EXCERPT FROM YELLOW CREEK LAKES DIAGNOSTIC STUDY


Southern naiad
1
3
5
N
500
250
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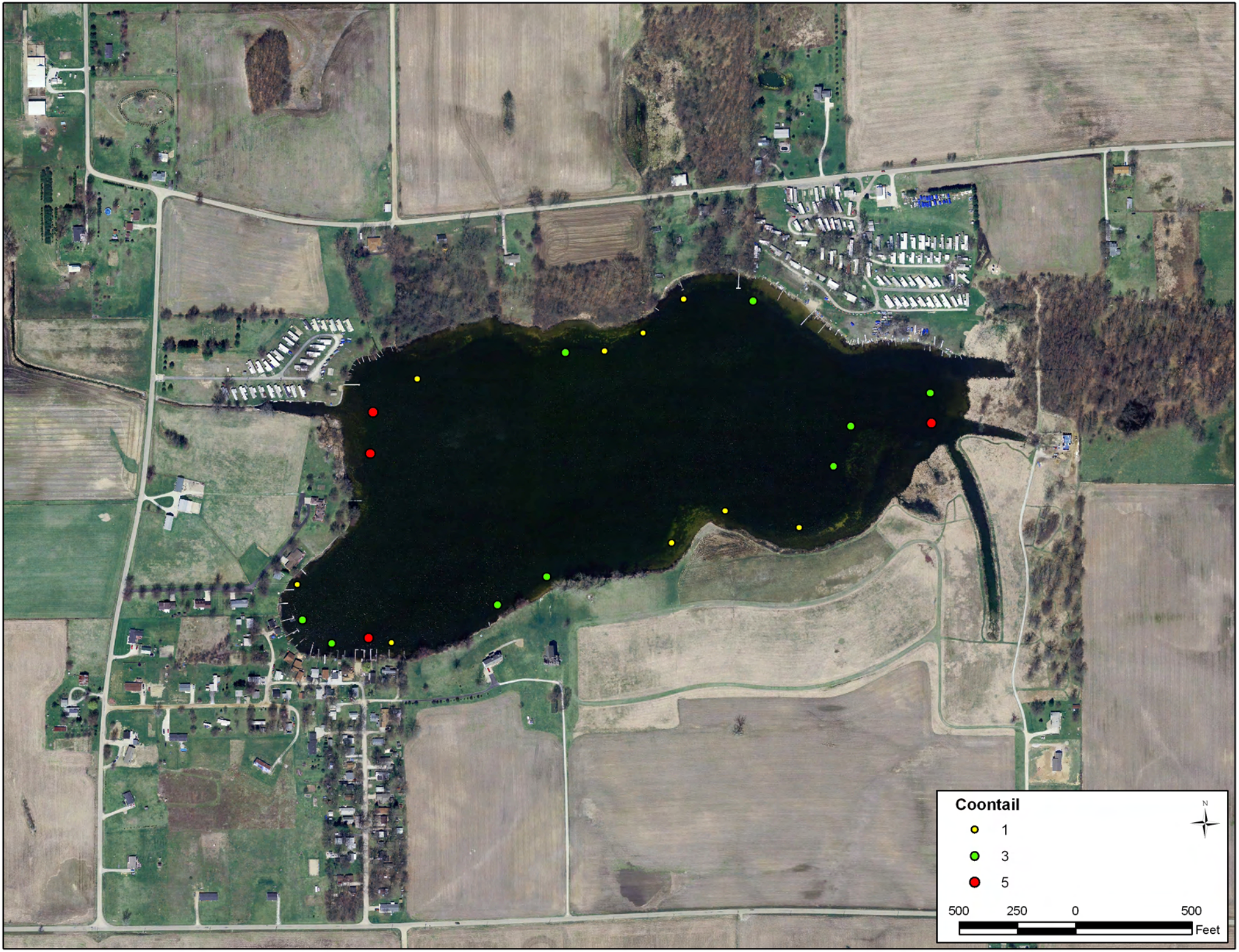
500
Feet


Coontail
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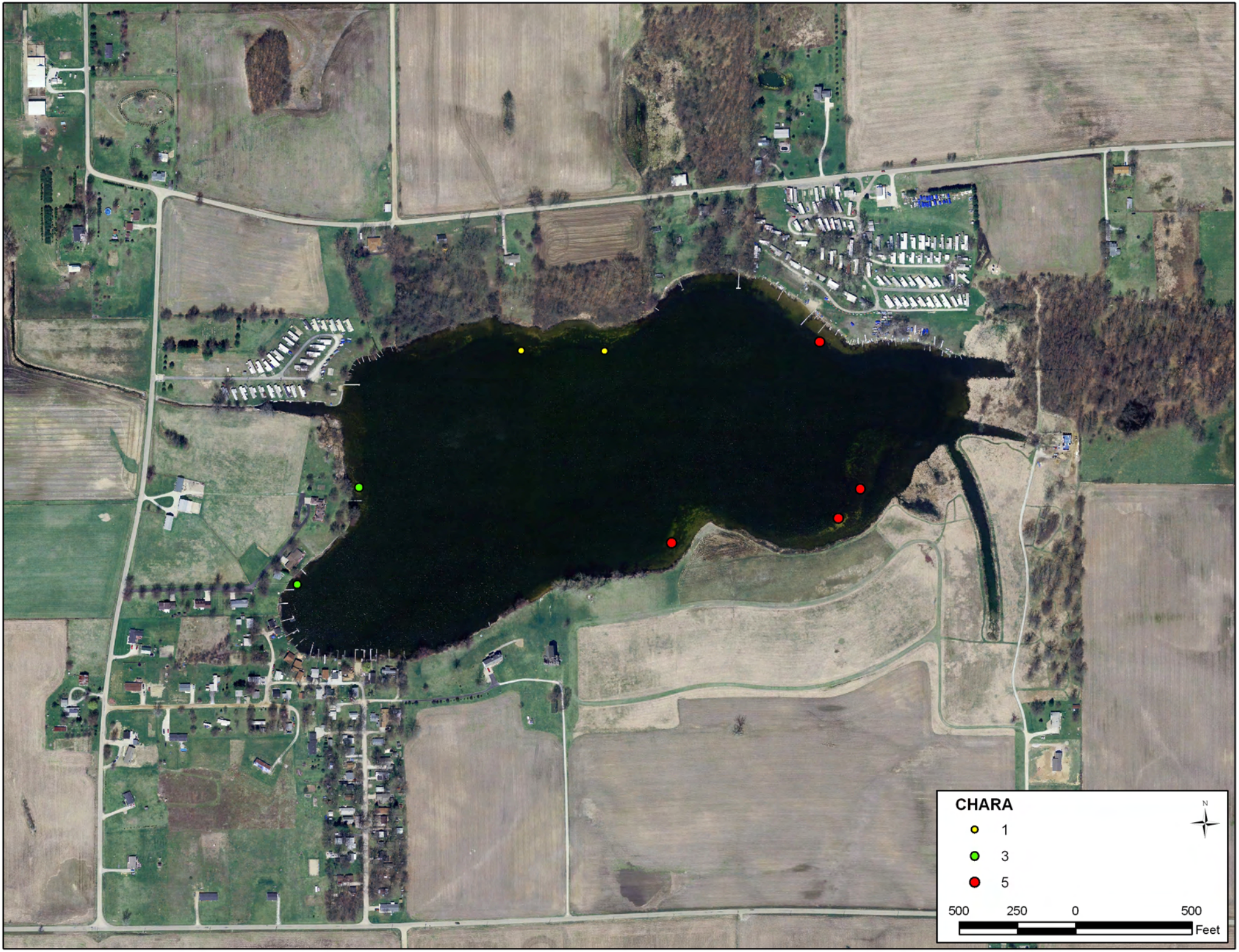
Feet


CHARA
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Feet